

Family Tortricidæ.

Genus ATTERIA.

Atteria rivularis, n. sp.

Nearly allied to *A. volcanica*; rather more golden in colouring, the black costal area of primaries broader, and the external border narrower; the transverse creamy-white streaks of costal area longer, and not united to one another at their lower extremities; the branching apical external streaks more transverse; five black spots within the lower half of the cell, one or two on the disk near the external margin, and sometimes several along the inner margin; secondaries with three disconnected marginal black spots at apex, and five along the external margin: below as above.

Expanse of wings 1 inch 3 lines.

Hab. Veragua (*Salvin*). Two specimens, B.M.

This species evidently takes the place of the New-Granadan *A. volcanica* at Veragua; it is a very beautiful insect.

Amongst the other Lepidoptera presented to the collection by Mr. Salvin, I may mention the very beautiful *Charidea arrogans* of Walker, *Flavinia leta*, and *Simena luctifera*, of which we previously only possessed the types (of *C. arrogans* four examples, and of the other two species a good series); also two examples of *Tosiomorpha longivitta*, Felder, which was not previously in the collection, but only differs in its superior size from Walker's *Josia penetrata*.

XLV.—*Tylenchus millefolii*, n. sp., a new Gall-producing *Anguillulide*. By Dr. FRANZ LÖW*.

ON the lowest leaves of the common milfoil (*Achillea millefolium*, Linn.), which usually form a small turf, from spring to autumn we find small gall-like inflations, 3-4 millims. in length, which are generally seated upon the midrib, less frequently at the base of the pinnæ, but always in the neighbourhood of the apex of the leaf. These inflations, which show no means of entrance or exit any where, are covered externally by the epidermis of the leaf, and are at first just as green as the rest of the leaf and equally hairy. The walls

* Translated by W. S. Dallas, F.L.S., from the 'Verhandlungen der k.-k. zoologisch-botanischen Gesellschaft in Wien,' Band xxiv. (1874), pp. 17-24.

are at first comparatively thick, firm, and full of sap; but towards autumn they gradually become thinner, less juicy, and wrinkled in folds, whilst their colour at the same time gradually changes to yellowish green. Two or three of these galls often occur upon one leaf, by which the latter is greatly deformed, as each gall causes an angular bending or twisting of the axis of the leaf.

If we open one of these inflations we see in its interior, with the lens, a soft whitish lump, surrounded and penetrated by a greenish yellow, somewhat viscous fluid. This whitish lump, when brought into contact with a drop of water, quickly flows asunder; and we then see, under the microscope, hundreds of *Anguillulæ* in all stages of development, twisting about one over the other with slow movements.

As in all known *Anguillulæ* of plants, the extraordinary vitality of this species after desiccation for months is very remarkable. I tested this tenacity of life, by taking a leaf bearing galls, collected in May and dried for my herbarium, and moistening it in October. Within a few hours all the *Anguillulæ*, which had been dried in it until they were quite brittle, were again lively. Even those which are repeatedly dried upon the object-slide of the microscope waken to new life after each moistening. This remarkable tenacity of life is confirmed by most authors. Dr. Julius Kühn, who discovered *Anguillula dipsaci* in the inflorescence and fruit of *Dipsacus fullonum*, Mill.*, found that this species came to life again when moistened with water after eight months' desiccation in a heated room. Bauer† states the duration of the capacity of revivification in *Anguillula tritici* at eight years. Baker‡ found that the young of *Anguillula tritici* enclosed in diseased grains of wheat could be revived even after a desiccation of twenty-seven years, by moistening with water; and this property, which the *Anguillulæ* possess in common with the *Tardigrada* and *Rotatoria*, was already known to Linné§.

But reviving as is the effect of moistening with water upon the dried *Anguillulæ*, remaining in it is equally injurious to them; for although they cannot exist without a certain amount of moisture, they die in water usually within a few days, as

* Zeitschr. für wiss. Zool. Bd. ix. (1858), p. 129.

† Ann. des Sci. Nat. tome ii. (1824), p. 154.

‡ Lettre de Needham en réponse au Mémoire de Roffredi dans le Journal de Physique de l'Abbé Rozier, 1775, p. 227.

§ Linné says of the *Anguillulæ* of vinegar and paste (Syst. Nat. ed. xii. tom. i. p. 1326):—"Chaos: Corpus liberum, uniforme, redivivum, artubus sensusque externis nullis. 1. *Ch. redivivum*, filiforme, utrinque attenuatum; habitat in aceto et glutine Bibliopogorum. Reviviscit ex aqua per annos exsiccatum: oviparum vel viviparum."

was also observed by Dr. Kühn in the case of *Anguillula dipsaci*.

I have hitherto met with the deformations produced by the Anguillulide under consideration on the leaves of *Achillea millefolium*, only in some parts of the Pfalzauenthal in the Wienerwald, and always only in very small numbers. Whether the whole plant is injured by it I could not ascertain, as I have always found it only upon the leaves of isolated plants of scanty growth standing upon poor soil, never upon strong and luxuriant plants.

The Anguillulæ themselves agree exactly in their principal characters with the other known forms infesting plants. The only specific differences are derived from the size and colour of the body, and the proportions of its parts to one another. But before indicating the specific characters of the milfoil-Anguillula, I will give an accurate description of it.

The Anguillulæ of the milfoil have an elongated body, attenuated towards the two ends, round in transverse section, and of undecided colour. They may be said to be translucent whitish with a greenish yellow shimmer. This shimmer, however, appears to proceed from their food, which in all probability consists of the above-mentioned greenish yellow fluid contained in the galls. By transmitted light the body is seen to be entirely filled with granules of different sizes and forms, which prevent any examination of internal organization. The external integument of the body is rather thick, quite smooth, and shining. In the middle of the anterior, obtusely rounded end of the body is the mouth, which is continued within into the œsophagus, which runs straight for a very short distance, and at a distance from the mouth equal to the transverse diameter of the body at the same spot presents a globular muscular dilatation. From this it runs backward in an indistinctly visible tortuous line, and at the second curvature loses itself entirely in the granular contents of the body. In *Anguillula dipsaci* Dr. Kühn observed that the portion of the œsophagus situated behind the globular dilatation was also somewhat tortuous, and presented at its extremity a second similar dilatation, which I could not detect in the Anguillula of the milfoil. The other Anguillulidæ (e. g. *A. fluvialis*, *aceti*, *glutinis*, *mucronata*, *linea*, &c.) possess similar rounded muscular dilatations of the œsophagus*.

The posterior extremity of the body is rather rapidly attenuated, and terminates in a much finer point than the anterior end. Prof. Grube has already indicated that all Anguillulæ

* Grube, "Ueber einige Anguillulen, und die Entwicklung von *Gordius aquaticus*," in Arch. für Naturg. Jahrg. xv. (1849), p. 358.

living in plants are oviparous*, and that they have their genital apertures in the vicinity of the posterior extremity of the body. This is precisely the case in the *Anguillula* of the milfoil; it is oviparous, and the genital apertures of both sexes are more or less near the caudal extremity. Their distance from the latter must be regarded, in the present state of our knowledge of these animals, as one of the best of the few specific characters. The male has a somewhat curved linguliform penis, rapidly attenuated from a broad base; this can be pushed forth from the anus, which surrounds it like a sheath, and opens obliquely backwards and outwards. The cleft-like anal orifice, which is placed transversely to the longitudinal axis of the body, has a slightly prominent margin, and is situated at a distance of one sixteenth or one seventeenth of the total length of the body from the end of the tail. Immediately behind the anus the transverse diameter of the body of the male diminishes considerably; it tapers off quickly to a point, which in the adult male is always bent almost angularly in a direction away from the anal aperture. In most cases the penis was retracted within the anus, so that the margins of the latter closed together; only in one individual did the apex of the penis project from the anal cleft, when it was distinctly seen to be a little broader than thick, *i. e.* tongue-shaped. The magnifying-power with which I worked did not enable me to see distinctly the two *spicula* and accessory parts, of which the penis of the *Anguillulidæ* consists.

A short distance in front of the male genital aperture, about the beginning of the last twelfth of the body, there originates a very delicate, perfectly transparent membrane, which extends over the above-mentioned genitalia to the hinder extremity, and is attached to the sides of the body. This membrane is usually tightly stretched, only appearing slightly folded transversely in dried individuals. When the male is laid exactly on his back, the membrane described is frequently seen to project a little laterally beyond the margin of the body; but in most instances this is not the case.

* As Linné was already aware (see note §, p. 343), the *Anguillulidæ* are sometimes oviparous, sometimes viviparous. These different modes of reproduction even occur in the same species; for Goeze reports ("Mikrosk. Erfahrungen über die Essigaale," in the 'Naturforscher,' Stück i. 1774, p. 34) that the *Anguillula* of vinegar bear living young after the manner of the Aphides, from July until autumn, and in the autumn lay eggs which survive the winter. Nay, even the same individual may be both oviparous and viviparous; for Claus states (*Zeitschr. für wiss. Zool.* Bd. xii. 1863, p. 354) that his oviparous *A. brevispina* is identical with Grube's *A. mucronata*, as in this species the same female produces her first brood oviparously and the later ones viviparously.

What functions this organ performs, and what are its relations to the genital organs, is still unknown. Dr. J. Kühn first discovered this organ in the male of his *Anguillula dipsaci*, and he also found it impossible to find any data for its elucidation in his repeated observations of that worm. With regard to the interpretation of this organ (which occurs in the males of all the species of the genera *Tylenchus*, Bast., and *Rhabditis*, Duj.) I agree rather with Kühn than with Bastian*, being, like the former, of opinion that it is stretched like a velum over the anal aperture; whilst Bastian thinks that two delicately membranous wings ("caudal alæ") are attached to the sides of the tail of the male, the contour of which is seen under the microscope both in the lateral and dorsal position. For if Bastian's opinion were correct, the membrane must appear much narrower in the lateral than in the dorsal position of the animal; but just the contrary is the case.

The female genital aperture is also situated near the hinder extremity of the body, and leads to a vagina directed vertically to the longitudinal axis of the body, which opens outwards with prominent margins, and there appears as a short transverse cleft (*vulva*). The distance of the vulva from the hindmost point is one eighth of the total length of the body. This [caudal] part of the body in the female is always slightly bent towards the ventral side, and does not diminish so rapidly as in the male. As already mentioned, the granular and vesicular contents of the body render all inspection of it almost impossible; and so I did not succeed in recognizing the internal sexual organs, the termination of the intestine, and the anal aperture in the female; on the other hand, I twice saw distinctly, in the interior of the body of the female, quite close to the vulva, a sharply defined egg, which showed precisely the same finely granular contents mixed with a few vesicles as the numerous eggs lying loose among the worms.

Males and females do not differ in length in this species. The greater number of them are almost exactly 1 millim. in length; only a few do not reach this size, and remain only 0·9 millim. long. But as exceptions exist almost everywhere, I found among the majority of females of nearly equal length one of 1·3 millim. length, and of proportionately increased thickness. As regards thickness, the males of the same length appear to be a little thinner than the females. It is, however, very difficult to give perfectly accurate, reliable measurements for creatures such as these little worms—as on the one hand, when alive they are never still, but are constantly bending, stretching

* "Menograph on the Anguillulidæ," Trans. Linn. Soc. vol. xxv. (1866). p. 125.

and pushing about; and on the other, when dead, although they may lie straight, they may always be unduly extended or contracted, which with such small individuals may easily cause a difference of 0·1 millim. or even more. The young Anguillulæ not yet sexually mature, which always occur associated with the fully developed and sexually mature individuals, and indeed in greater number than the latter, are of very different lengths according to the degree of their development. In the form of the body they resemble the sexually mature individuals; only the granules and vesicles of the contents of the body are larger.

The egg is about twice as long as broad, equally rounded at the two ends; its contents are finely granular, with several vesicles scattered through them. Some time before hatching, the young Anguillulæ may be seen through the delicate membrane of the egg. They lie elliptically curled up in the egg, following the form of the latter. When hatched they are about five times as long as the egg, or about one fifth of the length of the adult*. The circumstance that we almost always find together all the stages of development of the Anguillula of the milfoil, from the egg to the egg-laying individual, may be explained by supposing either that in this species several generations follow one another during the favourable season of the year, or that the oviposition takes place at very various times, as, indeed, Dr. Kühn supposes to be the case with *Anguillula dipsaci*.

The mode of life of the milfoil-Anguillula probably resembles exactly that of *A. dipsaci*, Kühn, *A. tritici*, Roffi, and other Anguillulæ of plants. The young asexual Anguillulæ winter in the leaf-galls; or the last-deposited eggs may winter outside the galls; and in the spring, when the galls are already rotted by the moisture of the soil, they quit them, creep upon the young shoots of the milfoil, bore into the still tender tissues of the expanding leaves, and produce upon them afresh the galls described at the commencement of this paper, in which they become further developed, and give birth to new generations. Towards autumn the original abundance of sap in the galls is gradually exhausted, their green colour passes to yellow; finally they become withered and wrinkled; and the individuals contained in them, which have never quitted the gall, stiffen or become dried up at the beginning of the cold season, to be awakened again from this apparent death only by the sunshine of spring.

* In the viviparous Anguillulidæ, such as *Anguillula acetii*, *glutinis*, *aviciatilis*, &c., the young are born still enclosed in the egg-membranes.

Bauer, Davaine*, and Bastian have made interesting observations as to the mode in which the *Anguillulæ* of the wheat get into the flowers of *Triticum vulgare*, Vill. Bauer sowed grains of wheat into the furrows of which he had introduced young individuals of *Anguillula tritici*, and found, by examining the plants from time to time, that the *Anguillulæ* ascended to the ears in the interior of the straw. Davaine, on the contrary, asserts that the *Anguillulæ* creep from without into the innermost sheath of leaves which surrounds the growing ear, and then penetrate into the extremely delicate parenchyma of the flowers at a time when all the parts of the flower exist as rudiments in the form of scales. Bastian, who successfully repeated Bauer's inoculation experiments, confirms Davaine's observations, which also agree with the opinions expressed by Dr. Kühn as to the mode of life of *Anguillula dipsaci*.

The *Anguillula* discovered by me producing galls upon the milfoil belongs to the genus *Tylenchus*, established by Bastian, and characterized by him as follows †:—"Body naked, tapering at the two extremities; extremity of tail without a sucking-papilla; integument with extremely fine transverse striæ; in the pharynx a protrusible spear with a trilobed base; œsophagus globularly dilated in the middle; intestine indistinct, covered with coarse, colourless fat-granules; vulva considerably behind the middle of the body; uterus unsymmetrical; the two *spicula* of the penis united to the posterior accessory piece; caudal alæ in the males not supported by rays; movements sluggish." To this genus Bastian refers, besides three species (*T. Davainii*, *terrivola*, and *obtusus*) established by him, *T. tritici*, Roffredi, of the wheat, *T. dipsaci*, Kühn, of the teasel, and the grass-*Anguillulæ* (*T. agrostidis* and *phalaridis*, Steinb.), which Steinbuch ‡ found in pouch-like galls in the flowers of *Agrostis sylvatica*, Huds., and *Phalaris phleoides*, Linn.§ It is probable that the producers of the galls found by Frauenfeld|| upon the leaves of *Gnaphalium Leontopodium*,

* Davaine, 'Recherches sur l'Anguillula du blé niellé,' Paris, 1857, pl. iii. fig. 12.

† [Dr. Löw seems to have modified Mr. Bastian's generic character, as this, although marked as a quotation, differs in some points from the description in Linn. Trans. vol. xxv. p. 125.—Ed.]

‡ 'Der Naturforscher,' 28. Stück (1799), pp. 233 & 255. Diesing, in his 'Systema Helminthum,' ii. p. 132, has described as a single species, under the name of *Anguillula graminearum*, the three species *A. tritici*, *agrostidis*, and *phalaridis*.

§ *Agrostis sylvatica*, Huds., is synonymous with *Agrostis polymorpha*, Huds.; and *Phalaris phleoides*, Linn., with *Phleum Böhmeri*, Wibel.

|| 'Verhandl. zool.-bot. Gesellsch. in Wien,' Bd. xxii. p. 397.

Jacq., and *Fulcaria Rivini*, Host, also belong to this genus, and perhaps the *Anguillula secalis*, Nitschke, which lives in the lower internodes of the rye*.

Almost all the species placed in this genus live in plants, and are for the most part gall-producers; for, according to Davaine's investigations, the cockled grains of wheat are not diseased seeds, but galls probably originating from the rudiment of a filament, as he found the aborted pistil in the diseased flowers; and Bastian (*l. c.* p. 87) further adduces, in support of this view, the fact that in his inoculation experiments the cockled grains were always formed on the diseased plants when the healthy stalks first began to flower. By analogy the little sacs in the flowers of grasses in which Steinbuch found the above-mentioned grass-*Anguillulæ* will also probably be not deformed fruits, but galls.

As the *Anguillula* of the milfoil differs from the other species of the genus *Tylenchus* by several constant characters, I describe it as a new species under the name of *Tylenchus millefolii*. The following is its diagnosis:—

Tylenchus millefolii†, n. sp.

Albidus, transparent, corpore in utroque sexu 0·9–1·3 millim. longo, extremitate antica parum attenuata, obtusa, rotundata, postica lentius acuminata, cauda maris (a pene) $\frac{1}{10}$ – $\frac{1}{7}$ corporis æquante, dorsum versus hamuli instar curvata, cauda feminae (a vulva) $\frac{1}{8}$ corporis æquante, ventrem versus paulo incurva. Distantia bulbi œsophagi ab ore latitudinem corporis eodem loco vix æquante.

Habitaculum: Gallæ in foliis *Achilleæ millefolii*.

XLVI.—*Experiments on the supposed Auditory Apparatus of the Culex mosquito.* By ALFRED M. MAYER†.

OHM states in his proposition that the ear experiences a simple sound only when it receives a pendulum-vibration, and that it decomposes any other periodic motion of the air into a series of pendulum-vibrations, to each of which corresponds the sensation of a simple sound. Helmholtz, fully persuaded of the truth of this proposition, and seeing its intimate connexion

* 'Verhandl. zool.-bot. Gesellsch. in Wien,' Bd. xviii. p. 901.

† [The worm is figured, with some details by the author (*l. c.* pl. i. B); but we have not thought it necessary to reproduce the figures, as the description is clear enough without them.—ED.]

‡ From the 'Philosophical Magazine,' ser. 4, vol. xlvi. No. 319.